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COMPOUND PRISM OF UNIFORM DISPERSION.—Messrs. C. G. Abbot and F. E. Fowle, of the Astrophysical Observatory at the Smithsonian Institution, have been investigating the possibility of obtaining a combination of glasses, the relative dispersions of which would enable a compound prism to be made having a uniform dispersion similar to that given by a diffraction grating (*Astrophysical Journal*, xi. pp. 135-139). Their initial experiments were suggested by finding that a parallel-sided combination of three prisms, of which the central one was rock salt and the outer ones glass, gave a much more uniformly dispersed spectrum than either prism used separately. Sample prisms of various kinds of glass were then examined, and after finding two with considerably varying dispersions, prisms were made of such calculated angles that the irregularities of dispersion would be partly eliminated when the prisms were combined in opposite sense, *i.e.* the base of one to the apex of the other. Taking two such prisms, of 5° 10′ and 20° angle respectively, and allowing the incident light to first enter the thick prism, then after passing through this and the adjoining thin one, to be reflected back from the last face of the thin prism over its previous course, it was found that the combination had an extremely regular dispersion, and although the wave-length curve shows two points of inflection, throughout the remaining portions long stretches could be selected where the dispersion is practically uniform. It is thought that for only moderate dispersions the uniformity found will be such as to render corrections unnecessary when comparisons are being made with grating spectra.

DYNAMICAL CRITICISM OF THE NEBULAR HYPOTHESIS.—In the *Astrophysical Journal*, vol. xi. pp. 103-130, Mr. F. R. Moulton discusses at some length the bearing of modern dynamical treatment on the various problems involved in the nebular theory of cosmic evolution enunciated by Laplace. The various criticisms put forward may be grouped into three categories: (1) comparisons of observed phenomena with those which result from the expressed or implied conditions stated by the hypothesis; (2) discussion of the question whether the supposed initial conditions could have developed into the existing system; (3) comparisons of those properties of the initial system with the one now existing, which are invariable under all changes resulting from the action of *internal* forces.

Under the first section of the discussion it is pointed out that the fact of the planes of the planetary orbits presenting considerable variations among themselves, and also that four satellites revolve in planes making practically right angles with the average plane of revolution of the system, are in direct contradiction with one of the chief deductions from the hypothesis. Other objections concerning observed phenomena are the unaccountable and suspiciously irregular distribution of the masses of the planets, and the unexplainable anomaly in the motion of the inner ring of Saturn.

The objections considered under the second category are that the lighter elements would have escaped from the mass; that matter would have been detached continually instead of in rings at rare intervals; that if a ring were contracted into a planet except an infinitesimal remainder distributed along its path, the process of aggregation could not complete itself; that the gravitation between the masses occurring in the rare media would be so feeble that they would seldom come in contact, and that Roche's limit and a similar new criterion show that fluid masses of the density which must have formerly existed would be disintegrated by the disturbing action of the sun.

In the third section of the inquiry the question of conservation of *moment of momentum* is alone considered, but the results obtained are in such discordance with those required by the hypothesis as to indicate that the original nebulous mass, so far from being in any sense *homogeneous*, was *heterogeneous* to a degree hitherto considered improbable.

Involved in the validity of the above statements is the question of the age of the earth, which has been calculated on the theory of the sun's contraction from a gaseous sphere arranged in concentric envelopes.

THE CAPE STAR CATALOGUE FOR 1890.—We have lately received from Dr. Gill, Her Majesty's Astronomer at the Cape of Good Hope, a copy of the catalogue compiled from observations made at the Royal Observatory. The measures were made with the Cape transit circle during the years 1885-1895, all being reduced to the mean equinox, 1890·0, *without proper motion*. Until June 2, 1889, observations of all stars were made by the "Eye and Ear" method, but on that date the chronographic method of recording was introduced, and since that time has been included for all stars except those within 10° of the Pole. Except in a few cases, a reversing prism has been generally used, thus eliminating any error due to the direction of the star's apparent motion through the field of the eye-piece. In the determination of the declinations, evidence of considerable wear was found in the brass screws of the micrometers. These were replaced by new ones of steel, and, as a further precaution, three of the six micrometers were rearranged so as to reverse the direction of the readings. The discussion of the ten years' observations with steel screws shows that the non-periodic corrections are still very marked, but that the effects of wear are practically eliminated by the plan of reversing the alternate microscopes.

In addition, the declinations have had to be corrected for flexure, refraction, and change of latitude, this latter being taken from Albrecht. Tables of the flexure and latitude variations are given.

The transit circle with which the observations comprising the present catalogue were made is non-reversible, and will be in future exclusively utilised for zone observations, a new instrument being in course of construction for fundamental work hereafter. Considerable pains have been taken to investigate the degree of error introduced by variations in magnitude. No sensible systematic error in declinations is traceable to this source, but in right ascension it is found that the average observer measures the transits of faint stars too late as compared with bright stars, and it is emphasised that in all future catalogues of precision this personal error depending on magnitude should be carefully determined for all the observers.

The catalogue proper consists of the positions for 1890 of 3007 stars, each being designated by its Cape number, and its respective numbers in the catalogues of Lacaille, Bradley, Piazzi, British Association, and Gould. After the positions the corrections are given for annual precession, secular variation and annual proper motion.

The volume closes with three appendices giving comparisons with other catalogues, special observations of α Canis Majoris, α Canis Minoris, β Centauri and α_1, α_2 Centauri, owing to these stars having companions of considerable mass, and a discussion of the places and proper motions of twenty-four circumpolar stars used at the Cape for determinations of azimuth.

FLINT IMPLEMENTS FROM THE NILE VALLEY.

THE latest number of the *Bulletin* of the Liverpool Museums contains a profusely illustrated paper, by Dr. H. O. Forbes, on a collection of stone implements from the Nile Valley, made by Mr. Seton-Karr in 1896, and purchased for the Mayer Museum. The great bulk of the collection was made in Wady el Sheikh, a tributary of the Nile, opening from the south-east into the mud-plain of the river opposite El Fent, which is situated half-way between the stations of Feshn and Maghagha on the railway from Cairo to Assiout.

The material of which the implements are made is chiefly a yellowish-brown or pale grey, opaque, earthy chert, and is but rarely of the translucent chalcedonic variety from the chalk of England. The collection contains a large number of types which may be classed as bracelets, axe-like tools, leaf-shaped flints, knife-like instruments, hoes or agricultural implements, fabricators, scrapers, cores and flakes, and nondescript stones. The bracelet series shows all the stages in the manufacture of these delicate ornaments, and proves that the suggestion of General Pitt-Rivers, who figured two complete similar examples in the *Journal* of the Anthropological Institute in 1881, is probably incorrect, that they were formed from "morpholites," or siliceous sphæroid-shaped bodies occurring in the marine limestone, encircled by a belt or ring, which is divided from the main body only by a thin partition, while sometimes the ring alone is found. The series figured in the paper shows that a flat disk of flint was first prepared, and that this was then perforated by a dextrous stroke of a chisel, and the opening gradually enlarged till sufficiently wide to admit the hand. Of the axe-like tools of which nine, and the knife-like instruments of which sixteen, are illustrated, several specimens

almost identical in form and size are figured by Prof. Petrie from Kahun, a XIIth Dynasty town, while others of the knives are of the same form as those seen in the process of manufacture in the wall-paintings of Beni Hasan. Many of the knives also bear a remarkable resemblance to the finest of those from Scandinavia. Several of the scrapers are almost black in colour, and, having a soft velvety surface, would pass for true palæoliths anywhere. Cores and flakes occurred in thousands along the Wady banks. Why so many thousands—all perfect as flakes—should have been struck off and never carried away is difficult to comprehend. Lastly, the collection contains a large number of long bars of stone partially worked, the use of which it is impossible to conjecture.

A map and several views are given showing Mr. Seton-Karr's collecting grounds along the Wady (Fig. 1); and these prove that the implements were scattered round the mines, excavations or pits whence the material was quarried. Each mine was also the site and the workshop of the skilled artificer. In many places shafts two feet in diameter were met with, often filled up with drifted sand, and surrounded by masses of excavated material neatly arranged round them. Their depth does not seem to have been great, nor do the flint-workers appear to have driven lateral galleries from the shafts. Most of the mines had a central work-place, round which the excavated material was heaped, and where most of the implements were found.

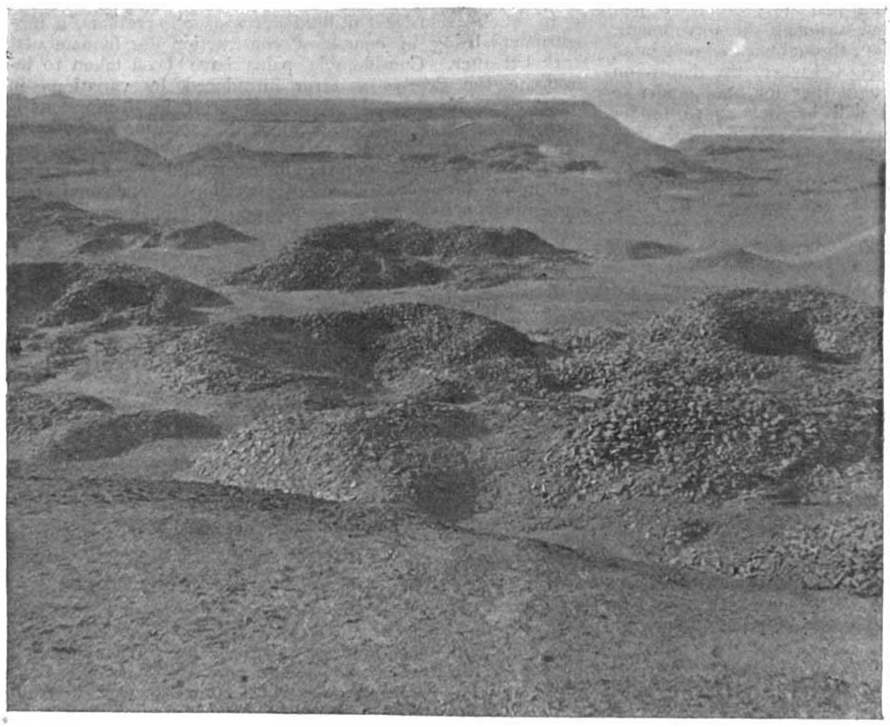

FIG. 1.—View of shafts on the level terrace-tableland, near Camp XI., 1896; showing the excavated material heaped round the central work-place.
(*From a Photograph by Mr. Seton-Karr.*)

The next questions discussed are the probable age of the Wady el Sheikh implements and how long the mines were worked. As no help in these questions is obtainable from legend or tradition, some clue is sought for in the patina or amount of discoloration the flints exhibit, for, according to Sir John Evans, "the safest, and indeed the most common, indication of an implement being really genuine is the alteration in the structure of the flints . . . and the discoloration it has undergone." A large proportion of the flints from the Wady el Sheikh are specimens broken in the making. In many instances the two portions, in falling to the ground from the maker's hands, dropped the one part with the upturned surface the reverse of that of its fellow, with the result that when the pieces are re-united the surfaces of the completed implement have each a moiety dark, the effect of exposure, and a moiety, in striking contrast, of nearly the original light yellowish-grey colour of the chert. In the two faces of the two halves every shade of patination from black through shades of yellow to the almost unchanged flint is to be found. Some gauge of the rate of this "æonic tinting" is given by Prof. Flinders Petrie, who states that "the old desert surfaces are stained dark brown by exposure during long ages, and this colour, varying from orange to black, is characteristic of all the flints of early age from this [Nile] plateau. It is certain that only a faint tinge of brown is produced on flints that are at least 7000 years old under like conditions, and this may give a slight scale of the ages that have passed since flint was worked here by palæolithic man." Dated by this standard, the bulk of the Seton-Karr collection ought to be many times 7000 years old. The great majority of the specimens, even the deepest stained, have their edges and the outlines of the flakings as sharp and unworn as the day they were made. A few, however, are deeply eroded by drifting sand, and others, in addition to their patination, have the glossy rounded angles and edges generally considered characteristic of palæoliths; there is nothing about them, however, to point to their being of a different age from their associates in the same workshop. All the implements were found round the mines; some are rude, because unfinished, and some are most beautifully flaked and finished knives (Fig. 2). A considerable number of the flints are so close in material, form and character to those figured by Prof. Petrie from the XIIth Dynasty town of Kahun, that there can be little doubt that both sets were made about the same centuries. Many of the implements are also of the same form as those pictured in the process of manufacture on the walls of Beni Hasan tombs belonging to the same dynasty and contemporaneous with the tombs. A few of the Wady el Sheikh instruments agree with some figured by Petrie as typical of the IVth Dynasty. The age, therefore, of the working of the quarries may be from 3900 B.C., but more probably from about the XIIth Dynasty; and consequently there is provided a scale for gauging the patination that can be acquired in that time. The amount of discoloration which appears also to vary with the quality or constitution of the flint, and the nature of the surface on which it lay exposed, would seem, according to the writer, therefore, to be a very uncertain criterion of age.

Hardly distinguishable from the flints of the Wady el Sheikh are numerous specimens found lying on the surface of the Nile plateaux by Seton-Karr, and near Esna and Ballas by Petrie and Quibell. "On the top of the 1400 feet plateau," the latter authors record, "are great numbers of worked flints of palæolithic type. . . . That the high plateau was the home of man in palæolithic times is shown by the worked flints lying scattered *around the centres where they were actually worked*. The Nile being far higher then, left no mud flats as at present for habitation; and the rainfall—as shown by the valley erosion and waterfalls—must have caused an abundant vegetation on the plateau where man would live and hunt his game." Along with the flints found in the Ballas desert, there were some "rounded flints, all stained dark brown; it is from such that these worked flints have been formed, and *the chips of working were scattered around*." After stating these facts, Dr. Forbes

continues, "it seems an extraordinary circumstance, and to me impossible to credit, that the nodules, the flakes and the implements should, notwithstanding the enormous rainfall . . . which ploughed out the side valleys opening on the Nile, be found lying, *even in a single instance*, in undisturbed association at the present day." The same criticism is passed upon the flint instruments also brought by Seton-Karr from Somaliland (of which the Liverpool Museum possesses a series), which have been described by Sir John Evans, before the Royal Society, as in form absolutely identical with some from the valley of the Somme and other places, and proving "the unity of race between the inhabitants of Asia, Africa and Europe in palæolithic times." Additional flints were later found "scattered all over the country, covering the ground sometimes for the space of half an acre," and there was discovered also an "unfinished spear-head on the ground surrounded by a mass of flakes and chips." This remarkable distribution over the country, Dr. Forbes remarks, "where no remains apparently exist of the deposits out of which they have been washed, seems difficult to reconcile with the usual process of denudation acting through the enormous period which has elapsed since the palæolithic age of Europe," and he disbelieves that "a nodule of stone surrounded by the flakes chipped from it tens or hundreds of thousands of years ago, could have remained undisturbed when the deposits by which it was covered have entirely disappeared"; he dissents also from the opinion that identity of form in the stone implements is sufficient evidence of unity of race or of close contact between the races who made them. He is of opinion, therefore, that none of the surface so-called palæolithic implements from Egypt and Somaliland "have yet been clearly proved to belong to that period, while the probability is that the bulk of them are of much later date." The only flint implements, Dr. Forbes adds, believed to be authentically palæolithic are the flakes and very rude scraper-like flints found by General Pitt-Rivers in the stratified indurated gravelly debris from a Wady near the Tombs of the Kings.

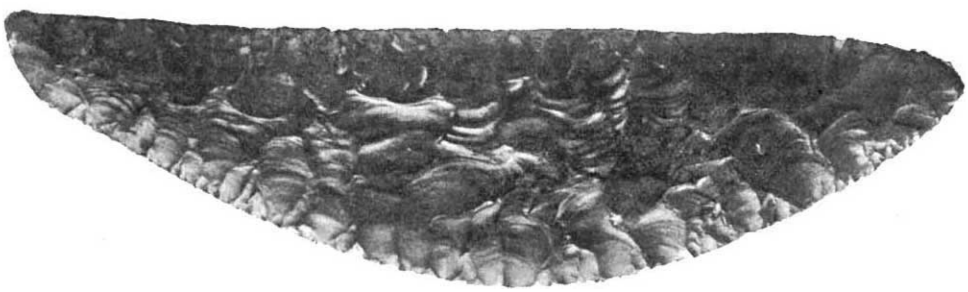

FIG. 2.—Flint knife from Wady el Sheikh.

ON THE MECHANISM OF GELATION, AND ON THE STABILITY OF HYDROSOLS.[1]

GELATINE-WATER-ALCOHOL and agar-water are colloidal mixtures which form a gel on cooling and a sol on warming. In both cases the formation of the gel is due to the separation of the fluid mixture into two partially miscible fluids or phases. When a certain critical temperature is reached, one of the phases separates out as a cloud of droplets. With a further fall of temperature either this internal phase or the external phase becomes a solid solution, and forms a framework in the spaces of which the still fluid solution is lodged. Thus two distinct types of gel occur. In the one the structure is a solid mass, in which are embedded spherical spaces filled with fluid. In the other it is an open sponge-work of adherent solid spheres with fluid filling the meshes. The former is firm and elastic, the latter is brittle and undergoes spontaneous shrinkage. In the ternary mixture the gel has the former structure when the gelatine content of the mixture is high; the latter when it is low.

The hydrogel of agar is built of a solid solution of water in agar, which forms a framework holding a fluid solution of agar in water. The concentration of each of these two co-existent solutions is dependent upon temperature, but the values vary according to whether the system is cooled down or warmed up to a given temperature. The system therefore manifests a striking hysteresis. From the point of view of the phase rule the hydrogel of agar is a system of two components in three phases—a fluid, a solid, and a vapour phase. The composition of the phases should therefore be fixed by fixing either the temperature or the pressure. Fixing the temperature, however, does not fix the composition, and this is probably due to two things: (1) the fact that the surface which separates the fluid and solid phases is curved, and (2) the fact that that surface is freely permeable by the mobile molecules of water, but is relatively impermeable to the immobile molecule of agar. The system obviously has two pressures which determine equilibrium, a lower hydrostatic pressure on the convex side of the curved surface, and a higher on the concave side.

Hydrosols, such as those of gold, silver or hydrosulphides, are systems in which equilibrium is between a solid phase dispersed as minute particles, and a fluid phase which is a true solution of the substance of the solid phase. The behaviour of the particles in an electric field shows that each one is surrounded by a double electric layer, which can be destroyed by the addition of electrolytes, or, in some cases, by the removal of all electrolytes. When this is done aggregation or coagulation follows. The stability of these hydrosols, therefore, is due to a contact difference of potential between the solid and the fluid phases.

The addition of an electrolyte may bring about coagulation either by altering the potential of the fluid phase, so as to make it agree with that of the solid phase, or by furnishing "nuclei" about which the particles of solid aggregate. When the particles carry a negative charge, acids act by decreasing the positive charge of the fluid; when the particles carry a positive charge, alkalies act by decreasing the negative charge of the fluid. In these cases the coagulating power of the acid or alkali is directly measured by its chemical activity when dissolved in water. The relation is expressed by the formula

$$K = n\alpha(v + \nu)$$

when K is the specific molecular coagulative power of a substance as measured by the volume occupied by one gram mol., when it just suffices to coagulate the hydrosol.

The coagulating action of a salt is due to only one ion, which is always of the opposite electrical sign to the colloid particles. The valency of the active ion exerts a remarkable influence upon its coagulative power, the relation being approximately

$$I' : I'' : I''' = K : K^2 : K^3.$$

Therefore, to express the coagulating powers of salts, a factor which is approximately squared or cubed by a change from monovalent to di- or tri-valent ions must be added to the formula given above.

$$K = n\alpha(v + \nu)A^x.$$

Thomson has pointed out that double electric layers must be separated by a region of finite thickness, in which the components are in a state of uncompleted chemical combination. The solid and fluid phases in these hydrosols, therefore, are separated by a layer which possesses considerable chemical energy, and which is of very great extent, and this may account for their marked catalytic or ferment-like properties.

[1] Abstract of two papers read before the Royal Society, on January 25, by W. B. Hardy.